FRACTAL DIMENSION OF UPLAND/LOWLAND CONTACT OF DEUTERONILUS MENSAE, MARS IMPLIES SHORELINE EROSION. S.C. Cull, Hampshire College, Amherst, MA 01002, **selby42@hotmail.com**.

Introduction: Multiple boundary contacts of the southern uplands and northern lowlands have been identified from Viking Orbiter images (1-3). In places, these contacts take the form of distinct escarpments, 1.5 to 2.5 kilometers high (1, 4), and have been likened to shorelines found along terrestrial paleolakes. It has been suggested that the escarpments may have formed due to wave action by an ancient ocean occupying most of the northern hemisphere (2).

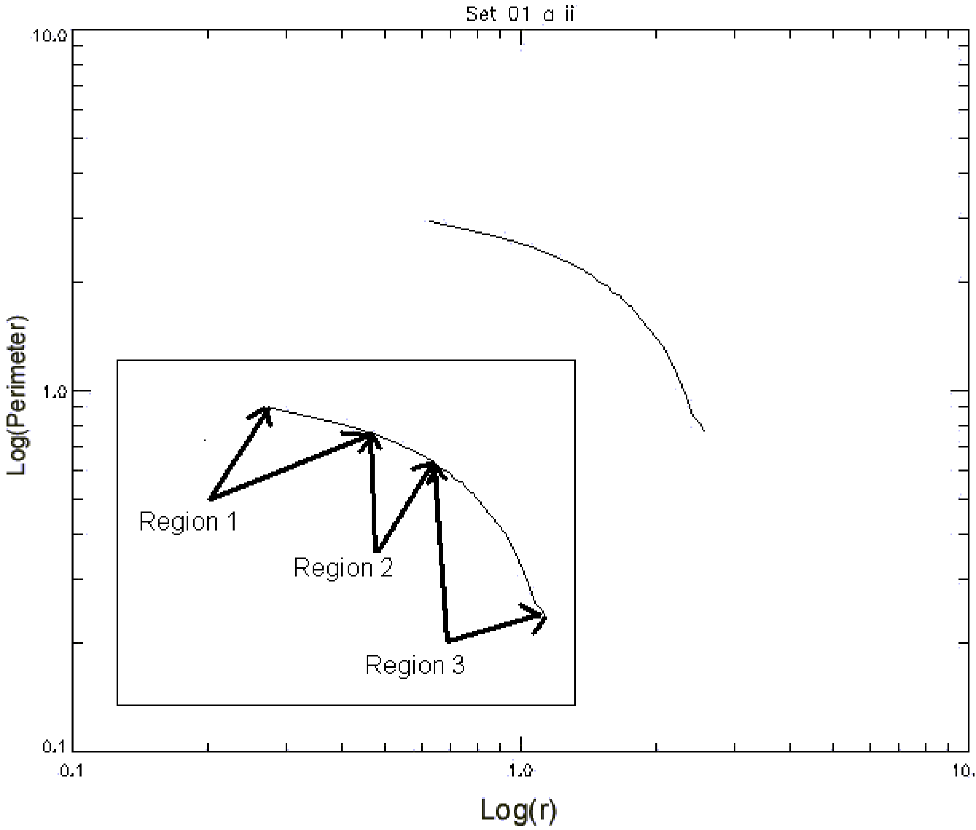
On Earth, some geologic processes create fractals. Lava flows produce fractal dimensions ranging from 1.12 to 1.42 (5,6); topographic contours show fractal dimensions between 1.20 and 1.25 (7); and shorelines formed from wave erosion display fractal dimensions ranging from 1.13 to 1.25, independent of age (8). If the upland/lowland contact escarpments on Mars were formed from wave erosion, they may retain some of their original fracticality, although some may have been wiped out due to later, non-fractal-producing wind erosion (9). I have analyzed a series of escarpments along the upland/lowland contact at Deuteronilus Mensae for their fractal dimensions.

Method: The classic way of analyzing the fractal dimension of a line (such as a coastline), is to overlay it with a series of boxes of given side-length, r, and count the number of boxes that contain part of the line, L(r). A decrease in r results in an increase in L(r), or an increase in the length of the line. Plotting log L(r) against log r produces a Richardson plot, and any straight-line segment in this plot identifies a region of fracticality, the slope of that segment being its fractal dimension (8). Values of r ranging from 1 to 1,000 pixels (0.64 to 640 km) were used for analysis of the escarpments.

I used U.S. Geological Survey mosaic MC-5 of the Ismenius Lacus Region, a 1:5,000,000 mosaic from the Viking 1 Orbiter, to identify and trace the escarpments. This region covered a latitude range from 30 to 65 degrees and a longitude range from –60 to 0 degrees. Though it would have been possible to use higher resolution images, it would have made little difference. If the escarpments are fractal, then they are scale invariant and resolution is unimportant. The mosaic was beneficial, since it allowed me to trace the boundary over a large region.

To reduce the amount of human error involved, each escarpment was traced and analyzed ten times. Each tracing was analyzed both with and without the following elements: eroded craters that were part of the escarpment, channels whose walls included the escarpments, and nearby mesas.

Results: The Richardson plots produced all showed the same behavior, with or without the elements listed above. For each plot, there are three separate regions. The first region, from 1 to about 20 pixels (0.64 to 12.8 km), is a result of the method used: small increases in r lead to small increases in L(r), producing a line segment that has absolutely no physical meaning. The second region is a distinct line, reaching from about 20 pixels to about 50 (12.8 to 32 km), and shows a fractal dimensions ranging from 1.20 to 1.25. The third region is not fractal, and drops off sharply, probably as a result subsequent non-fractal-producing erosion.



Conclusions: The escarpments along the upland/lowland contact of Deuteronilus Mensae are fractal, and therefore must have been created by a fractal-producing mechanism, such as tectonic uplift or wave-erosion. The fractal dimensions of the escarpments range from 1.20 to 1.25, which fall within the range of fractal dimensions seen in terrestrial shorelines. This suggests that the escarpments at Deuteronilus Mensae may have been eroded by wave-action at some point in their history.

References: (1) Parker, T.J., et al., 1989, Icarus 82, 111-145. (2) Parker, T.J., et al., 1993, J. Geophys. Res. 98 E6, 11061-11078. (3) Edgett, K.S., and Parker, T.J., 1997, Geophys. Res. Let. 24, 2897-2900. (4) Sharp, R.P., 1973, J. Geophys. Res. 78, 4073 - 4083. (5) Bruno, B.C., et al., 1992, Geophys. Res. Let. 19, 305-308. (6) Bruno, B.C., et al., 1994, Bull. Volcan. 56, 193-206. (7) Turcotte, D.L., 1997. (8) Mandelbrot, B., 1967, Science 156, 636-638. (9) You, J. et al., 1994, Earth, Moon, and Planets 71, 9-31.

This work was done while a student in Universe Semester at Columbia University's Biosphere 2 campus near Tucson, Arizona.